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Alternative crops for the prairies

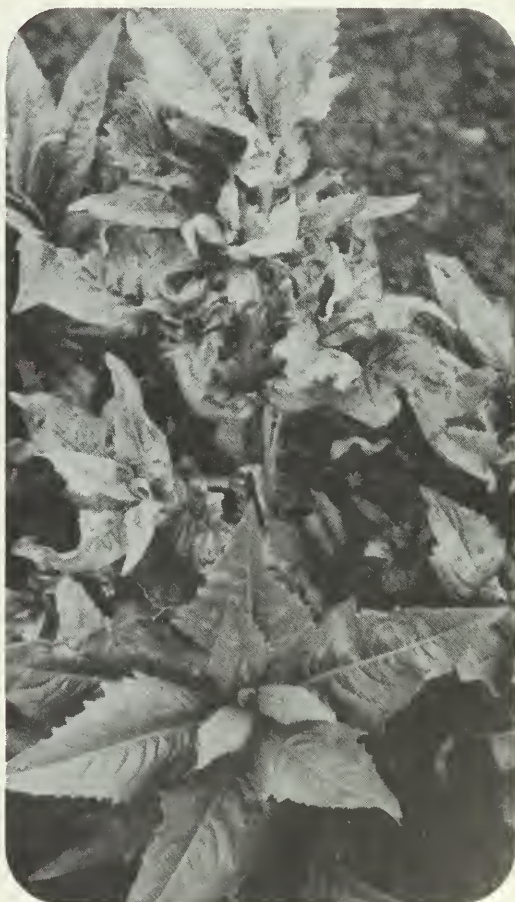
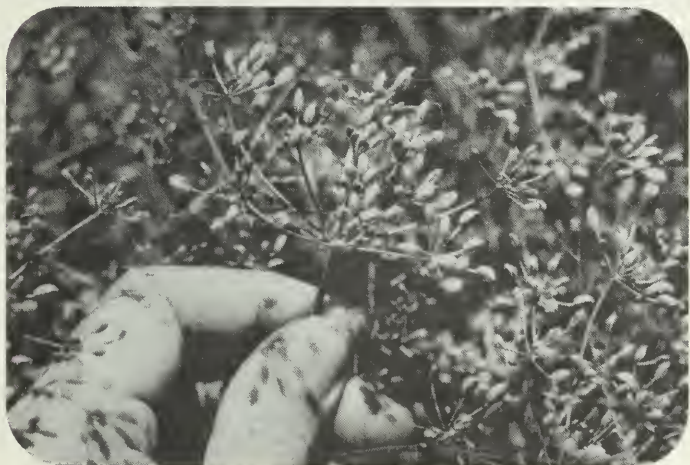


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Alternative crops for the prairies

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Recommendations for pesticide use in this publication are intended as guidelines only. Any application of a pesticide must be in accordance with directions printed on the product label of that pesticide as prescribed under the Pest Control Products Act. **Always read the label.** A registered pesticide should also be recommended by provincial authorities. Because recommendations for use may vary from province to province, consult your provincial agricultural representative for specific advice.

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Contents

Introduction 5

Azuki bean 6

Amaranth 8

Borage 10

Caraway 12

Coriander 15

Evening-primrose 17

Fenugreek 20

Foxtail millet 22

Japanese artichoke 24

Jerusalem artichoke 27

Lathyrus 30

Monarda 33

Niger 36

Poppy 38

Proso millet 40

Quinoa 42

Tepary bean 45

Introduction

Alternative crops can be produced as economic alternatives to existing crops and can complement and diversify farming operations and income.

Recently, the rapidly changing view on the over-production of some of Canada's traditional crops has increased the need for alternative crops. This continued pressure on the farm economy has caused producers to consider a broader range of crops that will enable them to increase cash flow, reduce their dependency on traditional crops, and allow greater potential for new markets.

Agriculture Canada's crop research is becoming increasingly important to producers, agricultural representatives, and others in the agri-food sector in their search for alternative crops. This publication attempts to respond to their need for information.

Concise, readily available information is also required on crops with very limited potential, or possibly none. Some of these crops have been included in this publication to document them in one convenient form, along with other new alternative crops with more potential.

Azuki bean

Botanical names: *Vigna angularis* (Willd.) Ohwi & Ohashi
[*Phaseolus angularis* (Willd.) W.F. Wight]

Common names: azuki bean, red bean, haricot azuki

Introduction

Azuki bean is an annual pulse that is native to the Orient, where it is a major crop, especially in Japan, Korea, and to a lesser extent, eastern China. North America, South America, New Zealand, parts of Africa, and India have also produced azuki beans to a limited extent. Japan is the largest market, where the milled seed is cooked and used as a base for pastries, candies, and other foods. Azuki beans are often boiled, fried, and eaten with rice. Whole beans are also sometimes popped like popcorn. The seeds are sprouted, eaten as a vegetable, and used to make soups and dhal.

Azuki bean is an erect plant with large yellow flowers. It produces tender green pods that turn straw yellow at maturity. Pod display is similar to that of field beans, with the preponderance of pods near the bottom of the plant. The beans in the pods are rusty red, and their shape differs from that of other beans in that the ends are flattened, giving them an angular shape.

Plants are 45–65 cm high. A plant produces about 10–20 pods, each containing 6–8 seeds; 1000 seed-weight is in the range of 120 g. For the more adapted cultivars, seed yield is in the range of 1000–1800 kg/ha. Frost damage can prevent plants from yielding. Maturity ranges from 109 to 120 days, placing this crop on the very extreme edge of production on the prairies.

Cultural information

Planting Plant seeds 3–4 cm deep, into a fine, firm, fertile, and well-drained seedbed. Seed from mid to late May to avoid late spring frost. If azuki beans are planted as a row crop, seed at approximately 45 kg/ha. If they are planted in narrow rows, seed at 50–60 kg/ha. Narrow-row seeding has a tendency to increase plant height and thereby pod height.

Fertilizer Use *Rhizobium* inoculants specifically for azuki beans. Apply phosphorous and potash according to requirements for field beans.

Weed control No chemicals are registered for weed control. Starting with a weed-free field or controlling weeds mechanically are the only recommended methods of weed control.

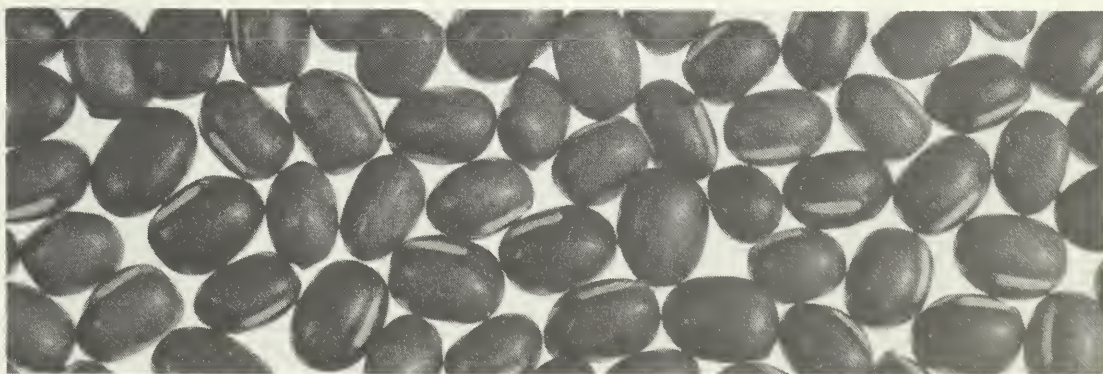
Diseases Several viral, bacterial, and fungal diseases are considered to be of major importance in the production of azuki beans.

Insects To date, only blister beetles have caused damage to the growing crop.

Harvesting Undercut row-cropped azuki beans when 75% of the pods have turned straw yellow, before the pods begin to shatter. Swath narrow rows or solid-seeded fields when nearly all the pods have turned color. Moisture stress resulting from a higher population causes the foliage to mature more rapidly, thus eliminating the need to undercut. Thresh the crop when the seed is at 14–16% moisture, using the same equipment and settings as for field beans.

Potential

Production of azuki beans is currently limited in Canada. Until earlier maturing genetic material is identified, the production potential of azuki beans on the Canadian prairies is precarious. Fluctuations in demand are another negative factor.



Azuki bean plants (*top*); seed (*bottom*).

Amaranth

Botanical and common names: *Amaranthus hybridus* L. (green amaranth)
A. cruentus L.S. (pigweed, purple amaranth, red amaranth, prince's-feathers)
A. hybridus var. *erythrostachys* (wild beet)

Introduction

Amaranth is the general name for a group of annuals that belong to the amaranth family. The plant originated in the Americas for use as a high-protein grain. It was developed by the Aztec and Mayan civilizations. This grain crop is now grown for its edible seeds in Central and South America, and to a lesser extent in North America. Amaranth is also grown in China and India, where it is mainly used as a green vegetable. The colorful foliage and the heavy red and green spikes also make it desirable as an ornamental wherever the growing season is long.

The grain amaranth species are related to the redroot pigweed, *Amaranthus retroflexus*. Preliminary tests have produced yields from 1400 to 2800 kg/ha. The plant is similar to redroot pigweed in growth habit. Plants are 1–1.9 m high. Large green- or red-seeded heads or stout terminal panicles are generally 20–45 cm long and 8–13 cm in diameter. The lens-shaped seed is slightly less than 1 mm in diameter and pale yellow. Judging by the growth and by yields produced under the hot, dry conditions of 1989, this crop appears to be relatively drought-tolerant. Either swathing or a severe frost is sometimes needed to facilitate harvesting.

Cultural information

Planting Plant in mid May, after the soil has warmed up to 10°C, at a rate of 1–2 kg/ha, 0.5–1.25 cm deep. The soil should be moist and the seed should be applied with a carrier for more uniform distribution. Row spacing depends on row crop equipment, but 90–100 cm is recommended. Space plants 2–4 cm apart, resulting in a desired population of 300 000 plants per hectare. Plant seeds into a fine, firm seedbed, on land that has not been treated with soil-incorporated herbicides the previous year. Sandy loam soils appear to be better than heavy clay soils.

Fertilizer This crop does not require high fertility. A fertilizer regime similar to that required by cereals is believed to be enough to produce good yields.

Weed control Plant the crop on land uncontaminated by chemicals. No chemical control is registered. Use mechanical control until the plants are 30 cm high.

Harvesting Cut plants in mid September, when the heads are maturing. Allow the plants to dry, and then combine them. Alternatively, combine them after drying, following an early killing frost. Seeds are mature when they are firm and have turned a transparent-like color. Clean the seeds and store them at a maximum moisture level of 11%.

Potential

This crop appears to have fair agronomic potential as a commercial crop in the southern Canadian prairies. The potential for production depends on the development of expanded markets.

The market for this crop is currently limited in North America, but it can be developed and increased. The seed has potential as a noncereal flour in several flour-based products. It can also be popped like popcorn or flaked like oats in oatmeal.



Amaranth plants (*top*); seed (*bottom*).

Borage

Botanical name: *Borago officinalis* L.

Common names: talewort, cool-tankard, bee bread

Introduction

Borage is an annual of the Boraginaceae family, which originated in the Middle East, probably in Syria. It is now widely cultivated in Europe and North America as a garden flower for bees and as a potherb. The seed is rich in gamma-linolenic acid (GLA), which has medicinal and pharmaceutical applications. A limited amount of borage is grown for these uses in Europe, the United States, and Canada.

Cultural information

Planting Plant seeds 1–2 cm deep, into shallow soil that is firm, rich, moist, and light. Planting can take place from mid to late May, after the danger of frost has passed. Good stands can be obtained by planting at 10 kg/ha in rows 30 cm apart.

Fertilizer Borage appears to require high levels of fertility to produce a maximum number of flowers.

Weed control Mechanical weed control is recommended. No chemical control is currently registered for this crop.

Diseases Some fungal and bacterial diseases occur, but they have not been accurately identified.

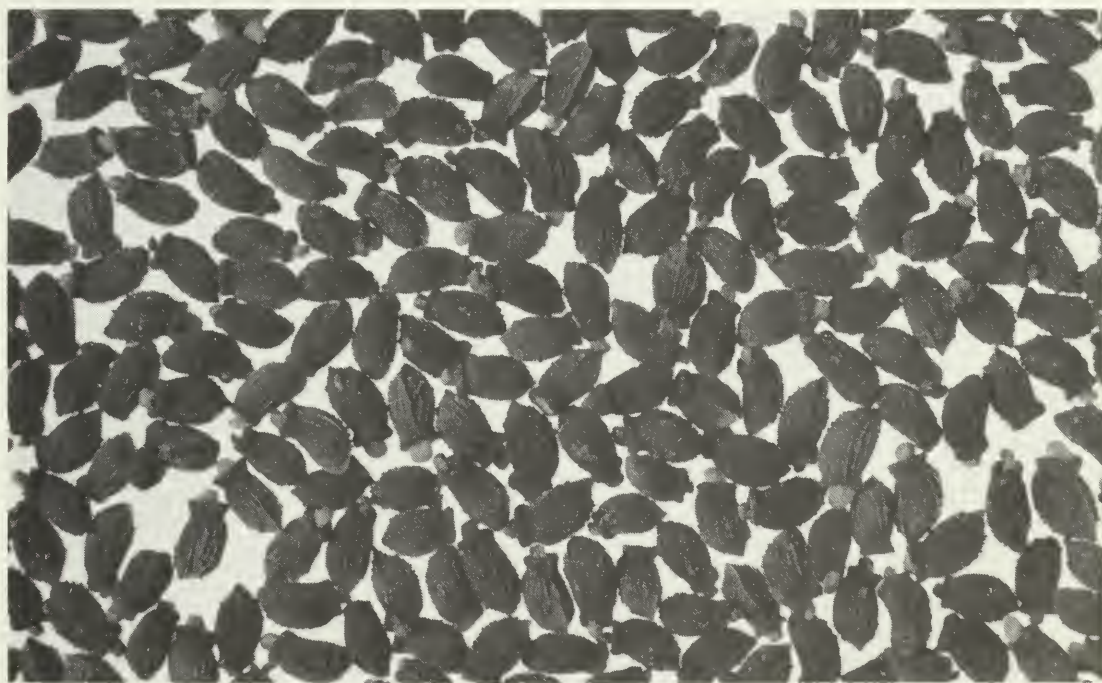
Insects No insect pests are noted.

Harvesting Swath the plants when most seeds have matured, and then combine them when the vegetative parts of plant have dried down. Straight-combining after the first frost is another harvesting option.

Potential

Borage oil rich in GLA is in demand, but the market is limited and difficult to penetrate.

Indeterminate plant maturity in this crop is a major agronomic constraint. The plant can produce 1200 kg/ha, but only 200–300 kg/ha have actually been harvested. Until genetic material of a determinate type is identified, this crop is unlikely to be produced on more than 500 ha per year in the Canadian prairies.



Borage plants (*top*); seed (*bottom*).

Caraway

Botanical name: *Carum carvi* L.

Common name: caraway

Introduction

Caraway is a member of the Umbelliferae family, native to Europe and naturalized in North America. This plant can be either annual or biennial, the latter providing the highest yields. The crop is grown for its seed, which is used to flavor bread and cheese, as a spice, and as a source of oil. The oil is used in the flavoring, cosmetic, and pharmaceutical industries. Most caraway is produced in the Netherlands and in eastern Europe, with limited production in Canada and the United States.

Seed yields range from 0 to 2500 kg/ha. Plants are about 55–75 cm high. Maturity usually takes place in mid August or slightly later in the second year, depending on temperature and available soil moisture. This crop tolerates light spring flooding.

Cultural information

Planting The optimum seeding rate for caraway is 8–10 kg/ha, planted less than 3 cm deep, in rows 15–30 cm apart. Seed caraway with a nurse crop that does not compete with the caraway seedlings and does not produce a dense canopy. Crops such as coriander, flax, and field peas at reduced populations are good nurse crops. Cereals may also be used at a 20–50% seeding rate, but in some years, even at these levels, the canopy may be too dense to allow the caraway seedlings to grow enough to survive the winter. Crops that produce heavy vegetative growth should not be used as nurse crops. The nurse crop seed and the caraway should not be placed side by side at the same depth. Caraway seed can be broadcast and then harrowed in, especially if it is amply watered near the soil surface.

Caraway is adapted to a wide range of soils but is more productive in heavier water-retaining clay to sandy clay and loam soils. Sandy soils should be avoided because of their low water-retaining ability. The seedbed should be firm, fine, and as level as possible.

Fertilizer Standard rates of fertilizer can be used for the nurse crop. An application of nitrogen at 30–50 kg/ha in the spring of the second year can significantly increase the production of caraway seed.

Weed control Clean, weed-free land is the best form of weed control for this crop. No herbicides are registered for use on caraway.

Diseases Several diseases can damage this crop: *Sclerotinia* (stem mold), stem browning, and root organisms can cause stand destruction and other reductions in yield and quality.

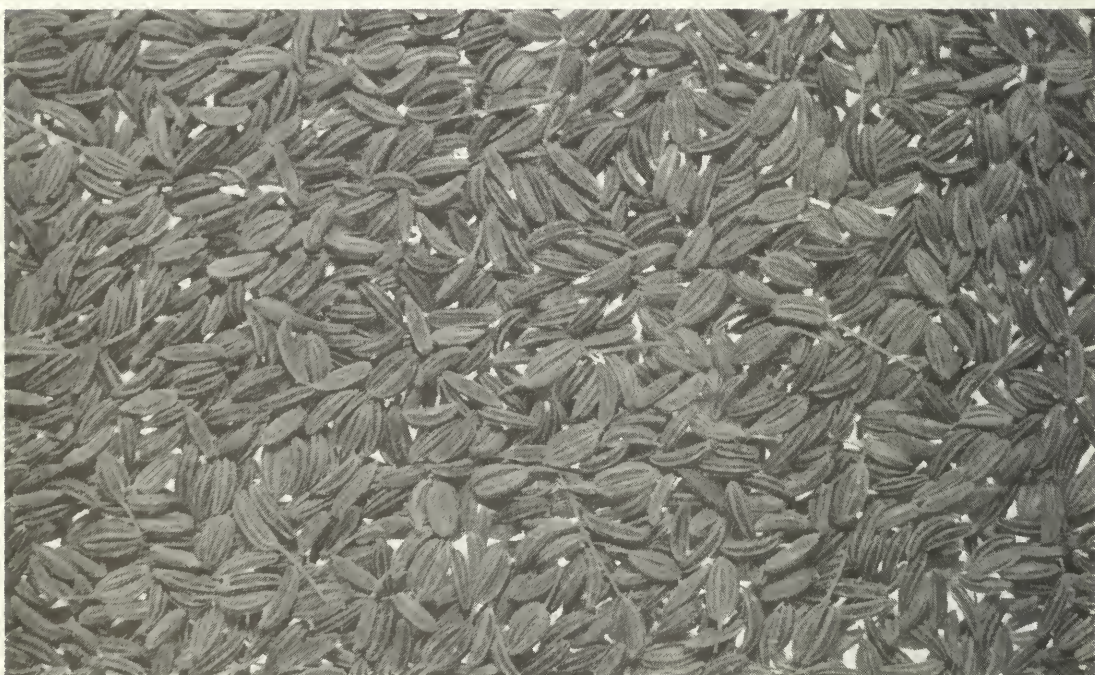
Insects No major insect problems have been identified, although the presence of aphids has been noted.

Harvesting Swath caraway when 20–30% of the seeds turn brown. The seed shatters easily when fully ripe. Hot weather may necessitate morning or evening swathing, when it is cooler and moisture levels are higher, thus preventing excessive loss from shattering. Very light rolling with a swath roller may help prevent wind damage. Combine caraway seed when the moisture content is 10% or less. If the weather is hot and dry, combining at night when it is cooler and damper may prevent seed damage and shattering. Caraway seed is combined easily with a slow cylinder speed and wide clearance.

Potential

Production of this crop is limited and entirely under contract.¹ Demand for the crop can be greatly affected by the level of production in Europe. Acquiring and maintaining an increase in market share, through consistent supply, could greatly increase the production potential of caraway.

¹ A contract ensures a market for a crop.



Caraway seed umbrel (*top*); seed (*bottom*).

CORIANDER

Botanical name: *Coriandrum sativum* L.

Common names: coriander, Chinese parsley, cilantro

Introduction

Coriander is a heat-loving member of the Umbelliferae (carrot) family, grown for its seed. It is used as a seasoning and for the extraction of essential oils. The mature seeds are pleasantly aromatic and are therefore also used to flavor baked goods as well as gin.

Coriander is native to the Mediterranean region, where it is currently grown. It is also grown in northern Europe, India, Argentina, and North America. Production in western Canada is only under contract and varies from as low as 100 to over 1000 ha annually. The plants are 45–50 cm high, maturing in 85–95 days, and produce an average field of 1800 kg/ha.

Cultural information

Planting Plant seeds after the soil temperature has reached 9°C, which is usually in May. This crop requires more moisture for germination than most other crops. The seedbed should be firm, moist, and finely worked, allowing the seed to be placed approximately 4 cm into the soil. Make good seed-to-soil contact, so that strong, uniform plants emerge. Space the rows 15–30 cm apart at a seeding rate of 18–25 kg/ha.

Fertilizer Fertilizer requirements are low. Nitrogen and potassium applied at seeding time, at a rate of only 10–15 kg/ha, produces acceptable yields on moderately fertile soils.

Weed control No chemical weed control is registered. A weed-free seedbed and mechanical means are therefore the only recommended methods of controlling weeds.

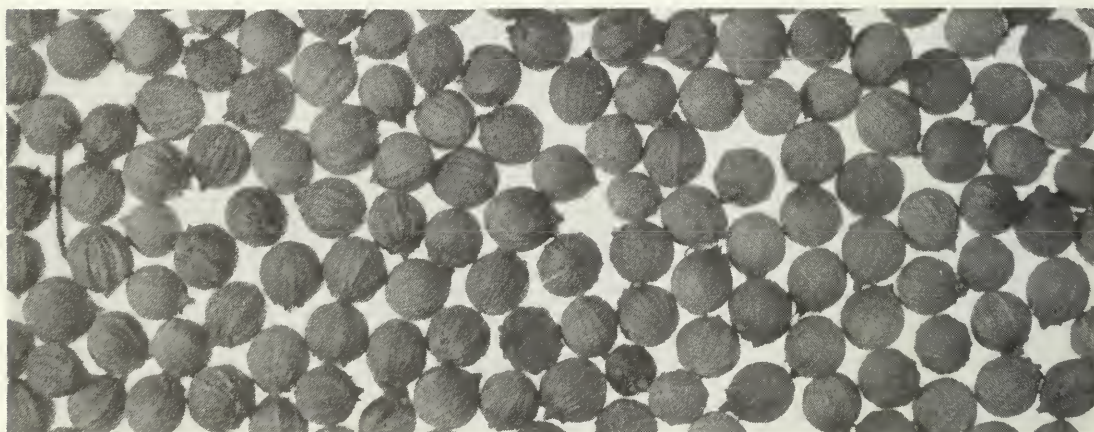
Diseases Several potential diseases occur, but none have been economically important to date.

Insects No major insect problems have been noted.

Harvesting Swath coriander as soon as the seed capsules turn brown; then combine when the moisture content is 15%. This crop may also be straight-combined, but the risk of loss is higher. Combine the crop in a way that minimizes damage to seed. A rate of splitting that exceeds 5% is considered unsatisfactory.

Potential

The current market for coriander is limited, with most of the production under contract. The market could be increased substantially by securing a larger portion of the existing world market.



Coriander plant (*top*); seed (*bottom*).

Evening-primrose

Botanical name: *Oenothera biennis* L.

Common name: evening-primrose

Introduction

A native of North America, evening-primrose is more common in eastern Canada and the northeastern United States than it is in the West. It is a relatively widespread weed on roadsides and wasteland or on gravelly and light sandy soils where competition is limited. Evening-primrose is a biennial or winter annual, thus producing seed only once in the plant's lifetime.

Evening-primrose is reproduced from seed. It grows into a rosette with a thick fleshy taproot. Spring growth usually produces a branched flowering stock, 1–1.6 m high. The flowering spike is up to 45 cm long with four-petaled yellow flowers that grow from the bottom and continue to the top. Numerous seeds are produced in capsules.

The seed is the source from which evening-primrose oil is readily obtained by conventional solvent extraction. This oil contains gamma-linolenic acid (GLA), which is used by the pharmaceutical industry and, to a small extent, by the health food industry.

Current production is limited and under contract only. Some evening-primrose is produced in Europe, and small commercial plots have been produced in the Maritime Provinces.

Cultural information

Planting Plant evening-primrose in early to late August so that the plants develop to the small rosette stage. Generally, the larger the rosette, the better the chance of winter survival. A seeding rate of 10–20 kg/ha is adequate for a good stand. Under less than optimum conditions the higher rate should be used. Place seeds in the top 1 cm of soil. The soils should be light, sandy, and well drained. Row spacing is determined by the need for chemical weed control and equipment used by the producer. A good firm seedbed is best.

Fertilizer Little added fertilizer is needed except when planting on soils extremely low in nitrogen. Adding nitrogen in the spring of the second year can increase plant vigor.

Weed control Mechanical weed control by inter-row cultivation is the only method recommended after planting. Little is known about chemical weed control; no chemicals are registered for this crop.

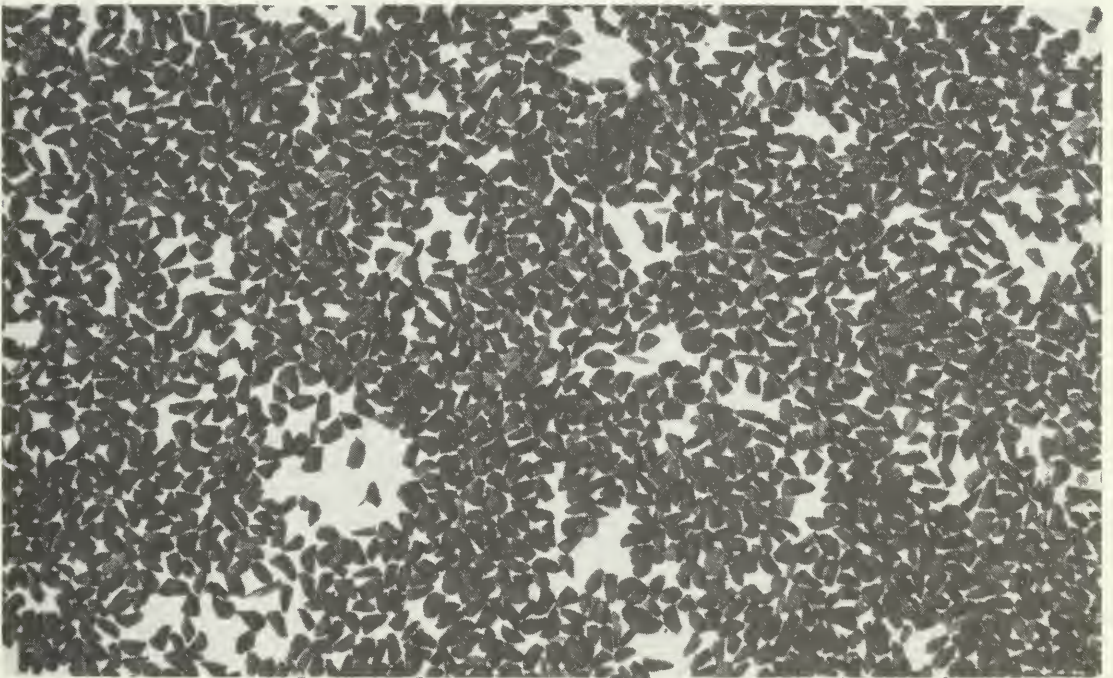
Diseases Downy mildew is a primary disease of this crop, although others have been observed.

Insects No serious pests have been identified.

Harvesting Because of the indeterminate nature of the plant's maturity, cut the crop when an optimum number of seed capsules are nearing maturity but the seed has not yet started to shatter. Swath the crop when the moisture content is 30–40% and combine when the moisture content is 12–14%. The average yield is about 450 kg/ha.

Potential

The potential of evening-primrose for use as a commercial seed crop in the Canadian prairies depends greatly on identifying or developing more adapted cultivars and increasing the market size. Winter kill often severely reduces the second-year plant stand.



Evening-primrose plants (*top*); seed (*bottom*).

Fenugreek

Botanical name: *Trigonella foenum-graecum* L.

Common name: fenugreek

Introduction

Fenugreek, a native of southern Europe and Asia, is a widely adapted legume with many uses. In the Mediterranean region it has traditionally been used as a forage crop. In India the seeds are used in curries, dyes, and medicine, and the whole plant is often eaten as a vegetable. In Europe and, to some extent, in North America the seed is used for its pharmaceutical qualities, as a spice, and in health food. The leaves are utilized in a variety of ways in health food.

Seed yields range from 150 to 3400 kg/ha, with an average yield of 1651 kg/ha. Plants are 47–50 cm high. The yellow, somewhat triangular-shaped flat seeds weigh 19–20 g/1000 seeds. The plant matures in 105–135 days. Under cool, moist conditions the crop is somewhat indeterminate in growth habit.

Cultural information

Planting Plant fenugreek into a well-drained, well-prepared seedbed, 2–4 cm deep. Space rows 15–30 cm at a seeding rate of 27–40 kg/ha with medium-sized seed for adequate results. This crop appears to be tolerant of light frost both early and late in the season. Plant seeds in early May after the soil temperature has risen slightly.

Fertilizer Requirements for fertilizer appear to be similar to those for field peas; both respond positively to a higher amount of added phosphate.

Weed control Fenugreek is not a strong weed competitor in the early growth stages. No chemical weed control is registered, and therefore a weed-free seedbed or mechanical means are the only way of controlling weeds.

Diseases This crop is susceptible to several potential diseases, including root rot organisms, powdery mildew, and cercospora. Cercospora can destroy a crop completely.

Insects Blister beetles and aphids are the most common pests.

Harvesting Cut the crop when half the pods turn yellow. Let the swath dry and then combine when the seed is golden in color and

contains approximately 12% moisture. Harvest with harvesting equipment used for grains and pulses.

Potential

The market for fenugreek is currently limited to its use as a spice, in health foods, and in the pharmaceutical industry. Fenugreek is agronomically suited to the prairie environment. Increased potential for production depends on the development of expanded markets.



Fenugreek plants (*top*); seed pods and seed (*bottom*).

Foxtail millet

Botanical name: *Setaria italica* (L.) Beauvois

Common names: foxtail millet, Japanese millet, Italian millet, Hungarian grass, Bengal grass

Introduction

Foxtail millet is native to Eurasia and is currently also grown in North America and Africa. The crop is most often used for forage, but the seed may be grown as grain or used in the pet food market, mostly for small animals and birds.

Foxtail millet is a small-seeded warm-season cereal grass. Generally, the stems are finer than those of proso millet. The plant is 90–150 cm high, with branching at the base. Heads are dense, somewhat nodding or erect, yellow to purple, cylindrical but tapering a little at the top, and up to 25 cm long and 30 mm in diameter. Foxtail millet usually contains bristles that are scarcely longer than the spikelet, but some can be more than three times as long. The bristles are tawny to brown-red to gray. The seed is small, nonglossy, and yellow to dark gray.

Dry-matter yields of forage range from 2090 to 6710 kg/ha, with a protein content of 8.2–12.3%. Seed yields range from 1335 to 5350 kg/ha.

Cultural information

Planting Plant foxtail millet that is intended for use as a forage after the soil has warmed up, from early May to as late as early July. For use as seed, plant before 1 June. Plant the seed less than 2.5 cm deep in a seedbed that is fine, firm, weed-free, and moderately well drained. Lighter soils are preferable to heavy clay soils. Seed at a rate of about 10 kg/ha for forage and 5–7 kg/ha for seed production. The crop is tolerant of moderate drought stress but produces much better under adequate moisture conditions.

Weed control No chemical weed control is registered. Control weeds with mechanical cultivation and delay seeding.

Fertilizer Response to various levels of fertility has not been documented.

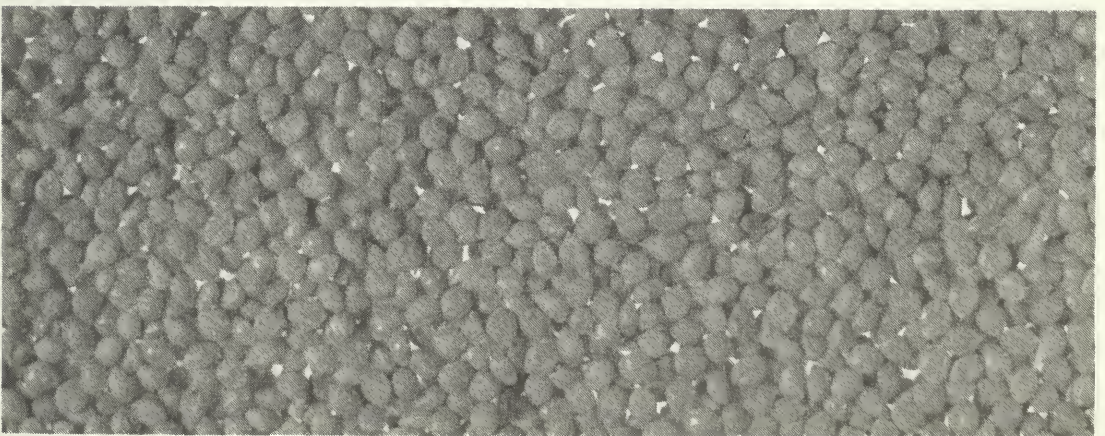
Diseases No significant disease damage noted.

Insects No major insect damage has been identified, but some damage can be caused by aphids.

Harvesting For foxtail millet that is to be used as a forage, cut as the seed is forming. For seed production, swath when most of the head has turned from green to yellowish. Combine the seed when dry, at a moisture level of 10%. Straight combine this crop when the total head has changed color. Dry the seed before storage. The longer the crop is left standing, the greater the potential for severe damage by birds.

Potential

Foxtail millet is a good forage and cereal grain crop in areas with a high potential for drought.



Foxtail millet plants (*top*); seed (*bottom*).

Japanese artichoke

Botanical name: *Stachys affinis* Bunge Miq.

Common names: Chinese artichoke, Japanese artichoke, knotroot, crosnes-du-Japon, korogi, choragi

Introduction

Japanese artichoke is an erect herb, with square hairy stems and green mint-like foliage. The plant is 30–45 cm high, usually 34–40 cm. Tubers are abundantly produced just beneath the soil surface, on the ends of the stolons. The stolons may be up to 30 cm long. The tubers are white, cylindrical (circular corrugated, tubular, or ridged), with three to eight circular grooves around each tuber. They are 2.5–5.5 cm long and 1.5–2.5 cm in diameter. Tuber yields range from 10 to 20 t/ha. Moisture stress can severely reduce yields.

This crop is cultivated in Japan and China for its edible tubers, which are generally consumed uncooked. More recently, the tubers are used as a vegetable in France.

Cultural information

Planting Plant in early May, in rows 45 cm apart for easy mechanical weed control, and allow 15–30 cm within rows. Using this plant spacing does not affect tuber yield. The plant compensates and fills in the space. The tubers appear to be marginally smaller with the more widely spaced plants. A light soil, such as sandy or sandy loam, is preferable.

Japanese artichoke is propagated from top-growth cuttings, rhizomes, and tubers. Tubers are the easiest and most effective method of propagation. The new plants obtain a more vigorous start by using some reserve energy from the seed tubers.

Fertilizer Response to various levels of fertility has not been documented.

Weed control Controlling weeds by mechanical means is recommended. No chemical weed control has been identified.

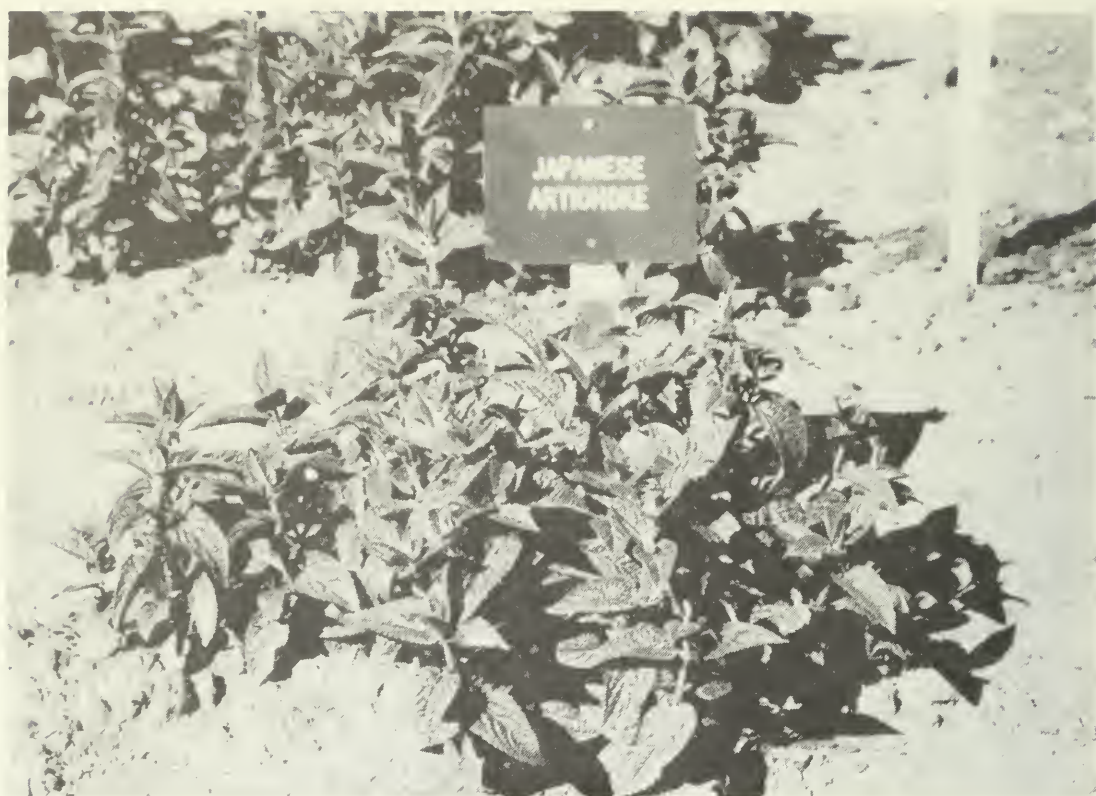
Diseases *Sclerotinia* appears to be the most serious disease that attacks this crop. The disease is prevalent, especially in heavy or poorly drained soils.

Insects No major insect damage has been identified. However, wire worms are reported to cause damage to the tubers.

Harvesting Harvest Japanese artichokes 100–130 days after planting by mechanically lifting the tubers out of the ground. Tubers must then be mechanically removed from the stolons at this point. The white tubers retain their appearance in storage at 5°C and in a sand or peat moss medium. The tubers also overwinter extremely well in the field as long as they are planted in a well-drained area. If storage conditions are too warm (15°C) or too dry the tuber may dehydrate or discolor, or both. If the tubers are stored at too cold a temperature (1°C), the starch or stachyose can be transformed into soluble sugars, causing spoilage.

Potential

The potential for production depends on developing expanding markets. Markets need to be developed for the raw or cooked vegetable or for the production of flour and other products from the dehydrated roots.



Japanese artichoke plant (*top*); tubers (*bottom*).

Jerusalem artichoke

Botanical name: *Helianthus tuberosus* L.

Common names: Jerusalem artichoke, girasole, sunchoke, sunroot, topinambour

Introduction

Jerusalem artichoke is native to North America. Its range extends from central Manitoba and Ontario south to Georgia and Arkansas. The plant, a relative of the sunflower, grows tall and upright to a height of 150–250 cm, depending on the cultivar. Growth habit may be branching or nonbranching. The plant produces 20–25 large, white, knobby tubers in a compact cluster below the main stem. Tuber yields are in the range of 40–50 t/ha, with maturity in 100–130 days.

Cultural information

Planting Plant in the spring, as early as possible. Large seed pieces of 45–60 g and whole tubers are preferable to cut tubers. Plant them in a well-prepared seedbed, 10–15 cm deep, within the hill, using potato-planting equipment, in rows 1 m apart; allow 30–35 cm within rows. This crop is highly dependent on soil water availability throughout the growing season but moisture is especially critical from approximately mid August to the end of September, when tubers are growing. Irrigation should be applied when conditions of severe moisture stress exist.

Jerusalem artichoke is propagated vegetatively, by planting the tubers. Light soils, such as sandy loam to sandy clay loam, are best. Heavier soils can produce good yields but at an increased harvesting cost and with misshapen tubers.

Fertilizer Nitrogen applied at a rate of 90 kg/ha, phosphorus at 50 kg/ha, and potassium at 50 kg/ha are adequate for producing Jerusalem artichoke tubers.

Weed control Inter-row cultivation is the only recommended method of weed control. No chemicals are registered for the control of weeds.

Diseases *Sclerotinia* and sunflower yellows, caused by *Pseudomonas*, are the major identified field and storage diseases.

Insects No serious insect pests have been identified.

Harvesting Harvest the tubers after a killing frost in the fall or early the following spring, using a modified commercial potato harvester to prevent excessive tuber damage or mechanical losses and to overcome

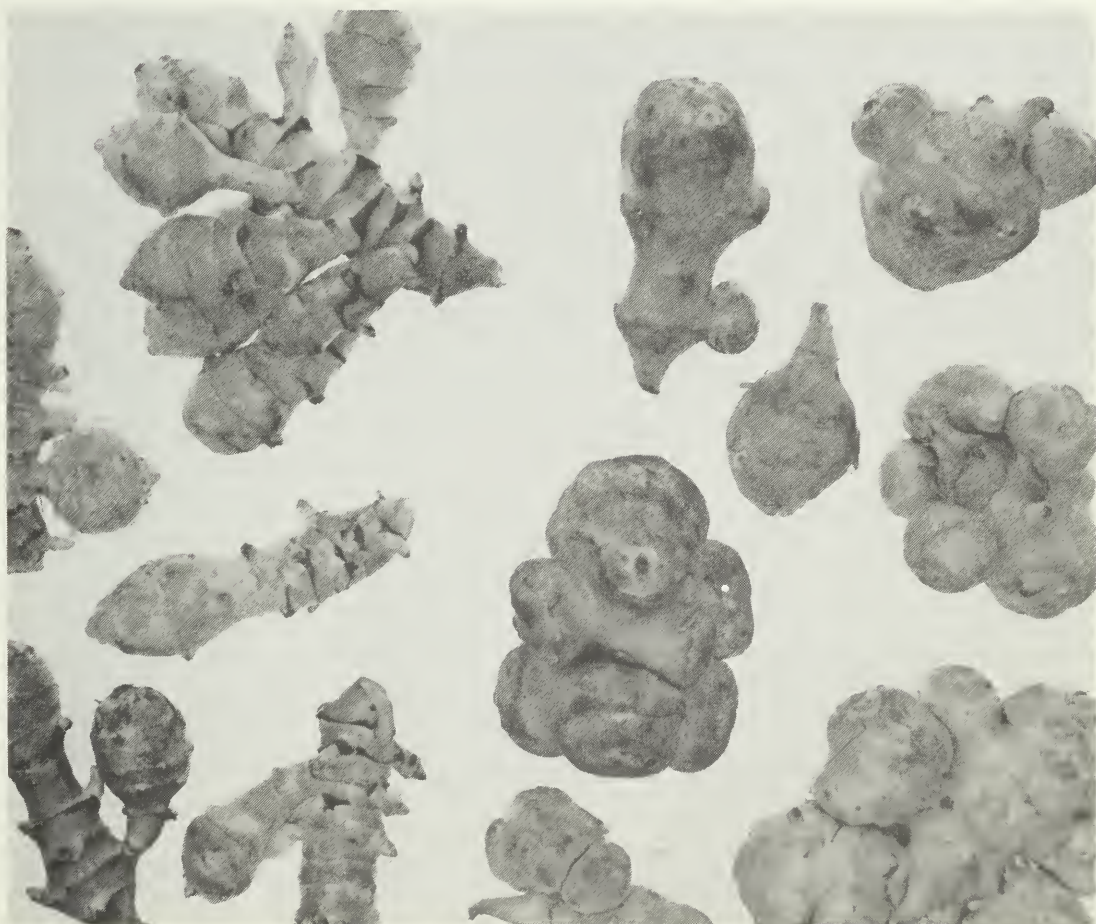
problems of plant-tuber separation. The tubers develop a thin periderm (outer layer), with little suberization (thickening of the skin); as a result they readily lose moisture and are subject to breakdown by disease organisms. A low-temperature and high-humidity enclosed environment is a successful method of storage. The tubers overwinter successfully in the soil and can subsequently be harvested in early spring.

Potential

This crop appears to have excellent agronomic potential because of its high tuber yield and wide range of uses. Product and market development are required before Jerusalem artichoke can be produced commercially.

Jerusalem artichoke has potential as a tuber or forage crop. Tubers may be used for high-fructose syrup, flour, ethanol feedstock, as a fresh vegetable, or for fructan production. Japan has shown interest in using it as a source of fructooligosaccharides, which are believed to favor growth of beneficial intestinal bacteria in humans and animals. Top growth may have potential as animal feed and as an ethanol feedstock, as well as for extracting various components.

Production in Canada and the United States is currently limited, primarily to the fresh-food market. As well, the top growth is used as an animal feed to a limited extent in North America and Europe. No major world or domestic markets exist for this crop, and product development is limited.



Jerusalem artichoke plants (*top*); Challenger tubers (*bottom left*); Columbia tubers (*bottom right*).

Lathyrus

Botanical name: *Lathyrus sativus* L.

Common names: grass pea, chickling pea, chickling vetch,
Indian vetch, lathyrus pea

Introduction

Lathyrus is an annual belonging to the legume family. It is commonly grown for grain, but can also be used for fodder or as a green-manure crop. Grass pea is indigenous to southern Europe and western Asia. It is currently grown primarily on the Indian subcontinent, with limited production in the Middle East, southern Europe, and some parts of South America.

The plant is a creeping vine that can vary in length from 30 cm to over 130 cm. It resembles field pea but its leaflets are longer and grass-like, giving it its common name, grass pea. The seeds are often white, brownish gray, or light cream; some are speckled with black. They are irregularly shaped, ranging in size from 3 to 12 mm. The protein content is very high, 26–28%.

The main limiting factor to the production of lathyrus in some countries is the presence of a neurotoxin, β -N-oxalylamino-L-alanine (BOAA). This neurotoxin causes irreversible crippling and paralysis in humans when lathyrus is consumed as a major part of the diet for an extended time, i.e., more than one-third of the diet for 3–4 months. An Agriculture Canada breeding program has produced lathyrus plants with BOAA concentrations reduced to 0.03% compared with 1–1.5% for lines grown elsewhere. Other lines with even less neurotoxin are currently being developed. Lines low in BOAA currently yield from 2500 to 3500 kg/ha. Maturity ranges from 100 to 115 days, with plant height averaging 80–90 cm. Seed size is 180–210 g. This crop is drought- and heat-tolerant, requiring little moisture to grow.

Cultural practices

Planting Lathyrus grows on a wide range of soil and moisture regimes, in most kinds of arable soils. To achieve high yields, plant in the first week of May. A seeding rate that produces 1 million plants per hectare results in optimum yields. The actual weight of seed per hectare depends on cultivar seed size but is somewhat similar to that of larger field peas. Equipment ordinarily used for pulse crops can be used to plant lathyrus.

Fertilizer Lathyrus appears to require a fertility level similar to that of field peas.

Weed control No chemical weed control is registered for this crop. A weed-free seedbed is currently the only recommended form of weed control.

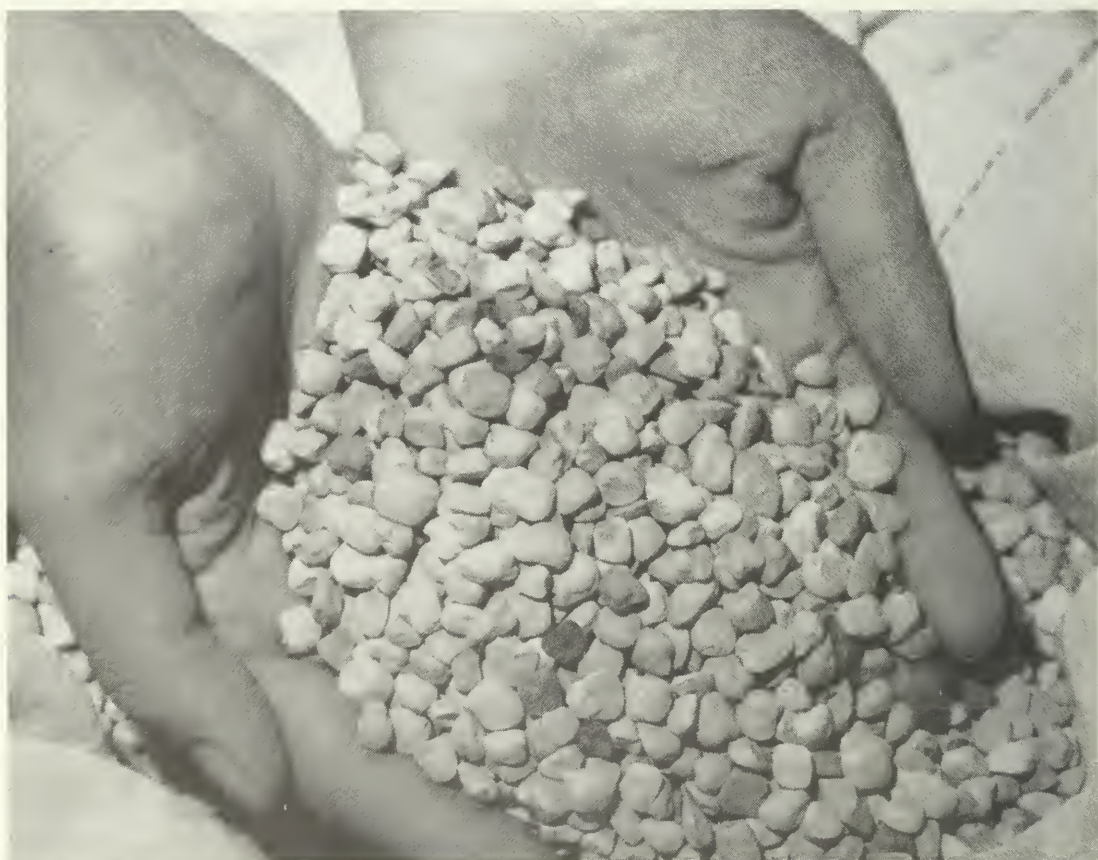
Diseases The most common diseases are powdery mildew and sclerotinia mold. Few others have been noted.

Insects Aphids are a major insect problem. Blister beetles, however, can also cause problems in some years.

Harvesting Swath lathyrus when 50% of the pods turn brown. Harvest when the seed has dried down to 16% moisture. If the crop is left in the field for an extended period after maturing, seed pods may shatter. If the seeds are exposed to long periods of wet conditions, premature sprouting occurs.

Potential

Because of its drought tolerance, this crop has excellent potential as a commercial crop in areas of low rainfall in the prairies (Brown and Dark Brown soil zones). In the prairies, drought greatly restricts the yield of most pulse crops currently produced. If current feeding studies determine the safety of this crop and potential markets are developed, future production could reach 10 000–100 000 ha.



Lathyrus plants (*top*); seed (*bottom*).

Monarda

Botanical and common names: *M. didyma* L. (bee balm, oswego tea)
M. citriodora Cerv. ex Lag. (lemon mint)
Monarda fistulosa L. var. *menthifolia*
(R.C. Grah.) Fern.

Introduction

Monarda is a perennial aromatic herb that is native to Canada and the United States. It is closely related to the *Mentha* (mint) family.

Monarda is grown for its essential oil, geraniol, which is colorless and has an agreeable rose-like scent. The oil is obtained by steam-distilling mechanically chopped whole plants, i.e., stems, leaves, and flowers. Geraniol is used by the fragrance industry in the manufacture of perfume, soap, and other products.

Other monarda selections (chemotypes) contain linalool, thymol, carvacrol eucalyptol, oct-1-en-3-ol, and other oil flavors.

The plants produce an oil content of 0.7–1.0% on a fresh-weight basis, with oil yields of 100–125 kg/ha. Plant height ranges from 60 to 80 cm, depending on soil fertility and moisture availability. The flowers are at full bloom by mid July but can be delayed somewhat by cool, moist environmental conditions.

Cultural information

Planting Monarda is effectively and rapidly propagated by rooting cuttings from actively growing stems. In late May and early June, take cuttings 10–12 cm long and remove all but two leaves. Place the cuttings in sand in a misting chamber for 2 weeks. After rooting, transplant them into a fine, firm well-prepared seedbed in rows 1 m apart, allowing 0.45 m within rows. Irrigate until transplants are established. Root divisions and tissue culture are other methods of propagating the plant.

Fertilizer Moderate fertilizer regimes suitable for most cereal grains are adequate for good yield production.

Weed control A weed-free planting area and mechanical inter-row cultivation are the only recommended form of weed control. No herbicides are currently registered for control of weeds in monarda.

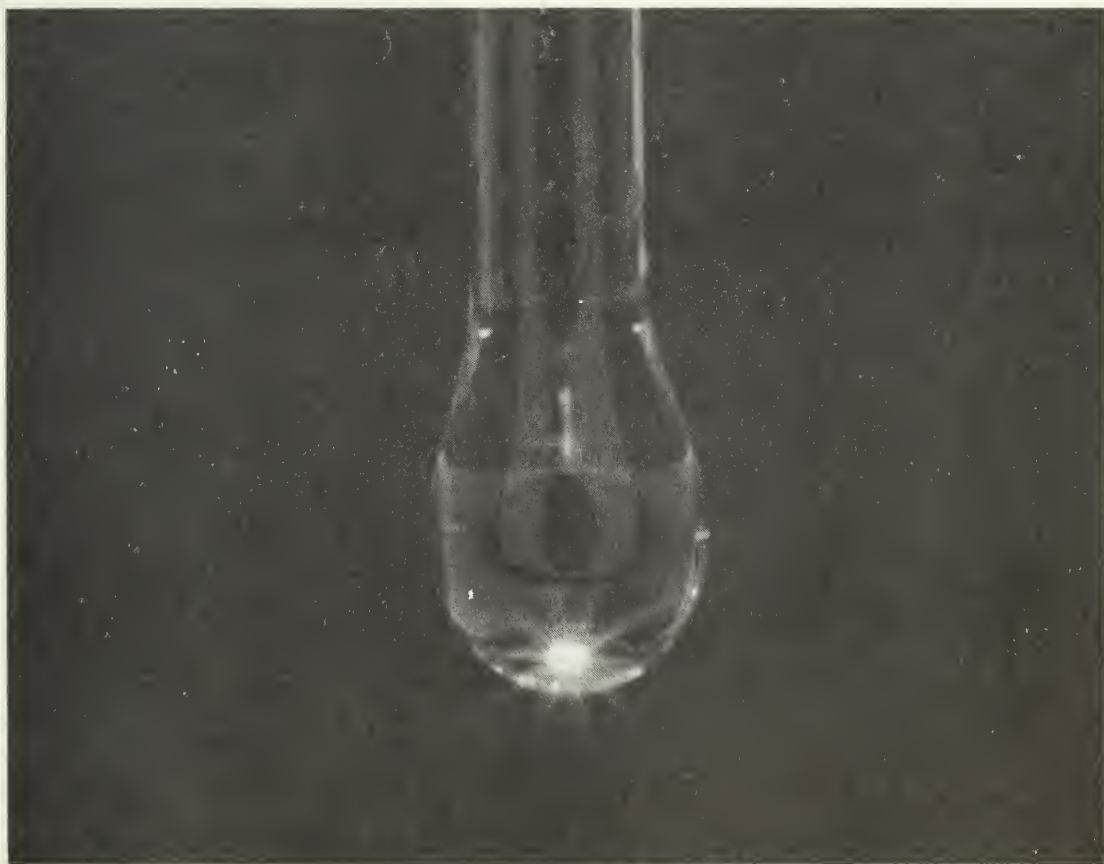
Diseases Rust and mildew are two major diseases. If it is not controlled, rust can cause defoliation, stem girdling, and plant degeneration. Genetic resistance to the rust has been identified. A virus-like disease has also been observed to destroy individual plants.

Insects No insect damage has been identified.

Harvesting Chop the whole plants mechanically when in 80–90% full bloom. Blow this silage into a distillation wagon, and extract the oil by steam distillation, using either hydro distillation or the hydro-diffusion method.

Potential

The potential for monarda appears limited to perhaps 1000 ha. With the development of more chemotypes to utilize new developing markets, however, crop production could be expanded significantly. Because of the specialized equipment that is required and its inherent high cost, the number of producers is expected to remain low.



Monarda plant (*top*); drop of geraniol oil (*bottom*).

Niger

Botanical name: *Guizotia abyssinica* (L. f.) Cass.

Common names: niger, ramtil, ramtilla

Introduction

An annual, niger is a native of Ethiopia, migrating to the Indian subcontinent at an early date. Niger belongs to the thistle family but has no spines on the leaves. The plants grow 75–120 cm high, producing many branches, most of which terminate in flowering heads. The flowers are like those of a wild sunflower; 15–40 seeds are often on a single head. The mature seeds are shiny black, thin, and about 10 mm long, each seed consisting of 30–40% protein.

The crop is cultivated for its seeds, which yield an edible oil. Chemically the oil is similar to that of safflower. Niger is grown mostly on the Indian subcontinent and to some extent in Ethiopia.

In India the oil is used for cooking, in paints and soaps, and for lighting. The meal is caked and generally fed to livestock. The seed is also used in birdseed mixtures.

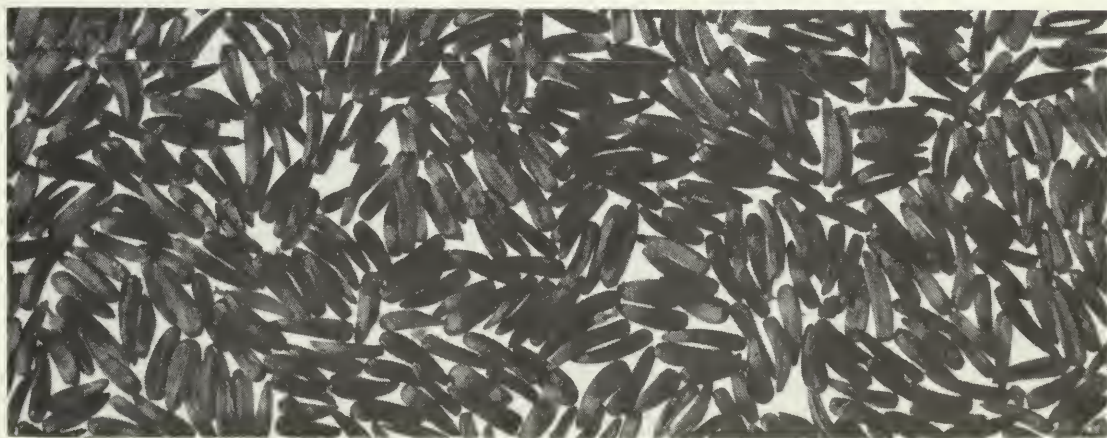
Problems

- late maturity, consisting of continued vegetative growth until late summer–early fall, when the reproductive stage has started but frost can cut short the maturity
- poor plant establishment
- shattering and other harvesting problems
- bird damage

Potential

We see no agronomic potential for this crop in western Canada unless a dramatic change occurs in the availability of high-yielding, early-maturing genetic material.

For additional information see *Niger and Safflower* a book published in 1961 by the Indian Central Oilseeds Committee, Ghandi Bhavan-Hyderabad - 1, Andhra Pradesh, India.



Niger plant (*top*); seed (*bottom*).

Poppy

Botanical name: *Papaver somniferum* L.

Common names: opium poppy, seed poppy

Introduction

Poppy is an annual herb with milky sap, native mostly to southeastern Europe and western Asia. It has been cultivated throughout recorded history as a source of seed, oil, and opium. In Europe it is widely used as a flavoring and to decorate buns, breads, and cakes.

In Canada and the United States the production of *P. somniferum* is strictly controlled. In Canada the Narcotic Control Act regulates its cultivation. The act is administered by Health and Welfare Canada's Health Protection Branch, International Control and Licensing Division, Bureau of Dangerous Drugs. Several other species of ornamental poppy do not, however, come under the provisions of this act.

Seed yields range from 1000 to 3000 kg/ha, extrapolated from a limited planting area. Plants are 0.6–1.3 m high. The plants mature in 100–120 days. The major problem encountered in producing this crop is the establishment of adequate stands. With good germination and emergence, stands are easily destroyed by moderate wind or blowing soil in exposed areas. Acceptable yields cannot be achieved with poor stands. Extended periods of high temperatures (35°C or above) during flowering completely destroy the crop.

Cultural information

Cultural information is minimal because limited experimental work has so far been conducted.

Planting Seed at a rate of 0.75–1.0 kg/ha, allowing a space of 0.5 m between the rows. The seedbed should consist of fine, firm, moist soil. Protect the area from strong winds and blowing soil, which also helps to establish a good stand. Planting in mid May produces acceptable yields.

Fertilizer No specific information is available.

Weed control Mechanical weed control is required because no herbicides are registered for this crop.

Diseases and insects Only aphids are noted as significant pests of this crop.

Harvesting For early-maturing lines, hand-harvest the capsules when completely dry, and remove the seed.

Potential

Agronomically, this crop has good production potential in Canada. However, a change would be required in the control restrictions to make it possible to cultivate this poppy in Canada. Yields of poppy seed from the nonrestricted *Papaver* species accessions evaluated are very low and therefore not commercially acceptable.

Proso millet

Botanical name: *Panicum miliaceum* L.

Common names: broomcorn, millet, hog millet, proso

Introduction

Proso millet is native to Asia but is grown in many areas of the world. It is a small-seeded annual cereal grass. Proso millet generally has coarse stems and grows from 60 to 150 cm high. The small seed is borne in a panicle that can range from very compact to very open. Superior cultivars generally have a compact panicle. Plant height ranges from 1.0 to 1.75 m.

Proso millet is used as feed, for forage, and for industrial products. In North America it is being grown to a limited extent, and its major use has been as the main component in feed for birds and small animals. In Canada 7000 t are processed annually, an amount that is increasing. Most of this amount is imported by Canadian firms and is then exported to Europe.

Cultural information

Planting The seedbed should be fine, quite firm, weed-free, and moderately well drained. Sandy loam, loam, and sandy clay loam are preferable to heavy clay soils. On the Canadian prairies, seed in early to mid May, when the soil temperature is warm (1–2°C warmer than for cereals). For some early-maturing lines, seeding as late as 1 June may be acceptable. Seed at a depth of less than 2.5 cm into a firm, fine, moist seedbed. Seeding rates can be as low as 5 kg/ha under ideal conditions, but they should be in the range of 10 kg/ha, and up to 25 kg/ha if used for forage.

Fertilizer Nitrogen levels somewhat lower than those recommended for wheat and other cereals produce acceptable millet seed yields.

Weed control Because no herbicides are registered for this plant, planting on clean, weed-free fields is currently the only available method of weed control.

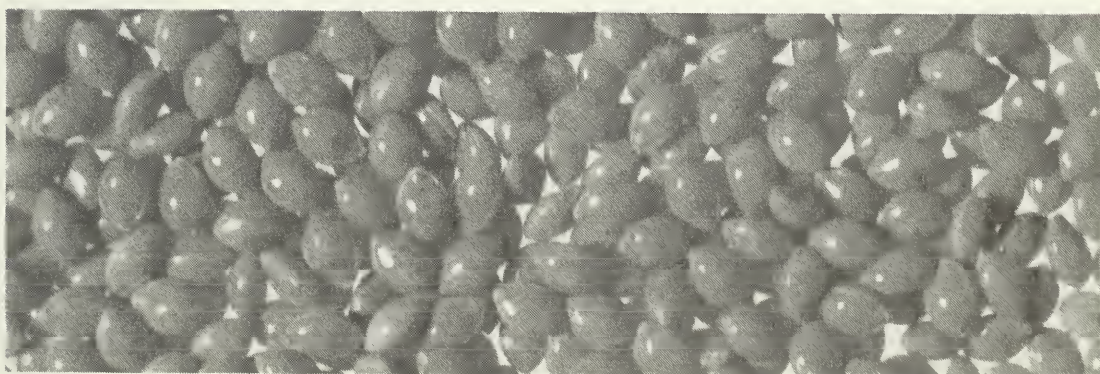
Diseases and insects No major diseases have been identified. Heavy aphid infestations may cause slight reductions in yield.

Harvesting Swath the crop when the top one-half to two-thirds of the panicle is ripe or has turned yellow, and the remainder has firm green seed. Combine when the seed is dry. This crop may also be straight-combined when most of the panicle has changed color, and the

remainder can be easily rubbed out by hand, but this method increases the risk of shattering losses. This method of harvesting also requires the seed to be dried before storage. Lines adapted to the prairie environment mature in 99–108 days. Proso millet uses water efficiently and is therefore drought-tolerant, but it does best under warm-season conditions with an adequate moisture supply. Yields range from 1800 to 5800 kg/ha. The average for Crown is 3871 kg/ha and for AC Prairie Gold, 4450 kg/ha.

Potential

Production of this crop is limited, 1000–2000 ha in western Canada, all of it under contract. This market growth is potentially good. Proso can become a significant commercial crop of 10 000–15 000 ha or more.



AC Prairie Gold proso millet plant (*top*); seed (*bottom*).

Quinoa

Botanical name: *Chenopodium quinoa* Willd.

Common names: quinoa, Quinoa, Inca rice, vegetable caviar, mother-of-grains

Introduction

Quinoa is an annual belonging to the goosefoot family and is closely related to the common weed, lamb's-quarters (*Chenopodium album* L.). Quinoa is produced mainly as a seed crop in the Andes of South America, mostly at altitudes of 2000–3000 m. The seeds are a staple cereal food of the indigenous people of the Andean highlands.

This species is relatively frost-tolerant after seed has formed. Quinoa is similar in appearance to lamb's-quarters, but with a heavier seed head. The seed is 1.5 mm in diameter, slightly smaller than millet seed. It is flattened on two sides and is yellow-brown. The plants are 0.7–1.8 m high. Seed yields range from zero to 1200 kg/ha, depending on the type of season experienced. The plant matures in 95–115 days.

The seed of quinoa is not a true grain but a fruit. Quinoa is sometimes called a pseudo-cereal or pseudo-oilseed because of its unusual composition and chemical balance between starch, protein, and fat for energy storage. The seed is used in soups and mixed grain dishes to make breads, biscuits, cakes, and porridge.

Cultural information

Planting Plant in early May, when the soil temperature is 7°C at the surface, to a depth of 1–2.5 cm into a fine, firm, weed-free seedbed consisting of sandy loam to loamy sand. The seed rate should be 0.85 kg/ha to obtain a stand of approximately 300 000 to 325 000 plants per hectare, allowing 30–35 cm between rows and 7–15 cm within rows. A trifluralin-type herbicide should not be used on the seedbed in the previous year.

Fertilizer Fertilizer requirements have not been precisely determined, but moderate to high levels of available nitrogen appear to be required for optimum yields. Available nitrogen at a rate of 100–150 kg/ha should be adequate. Water requirements are relatively low, 300 mm or more per season.

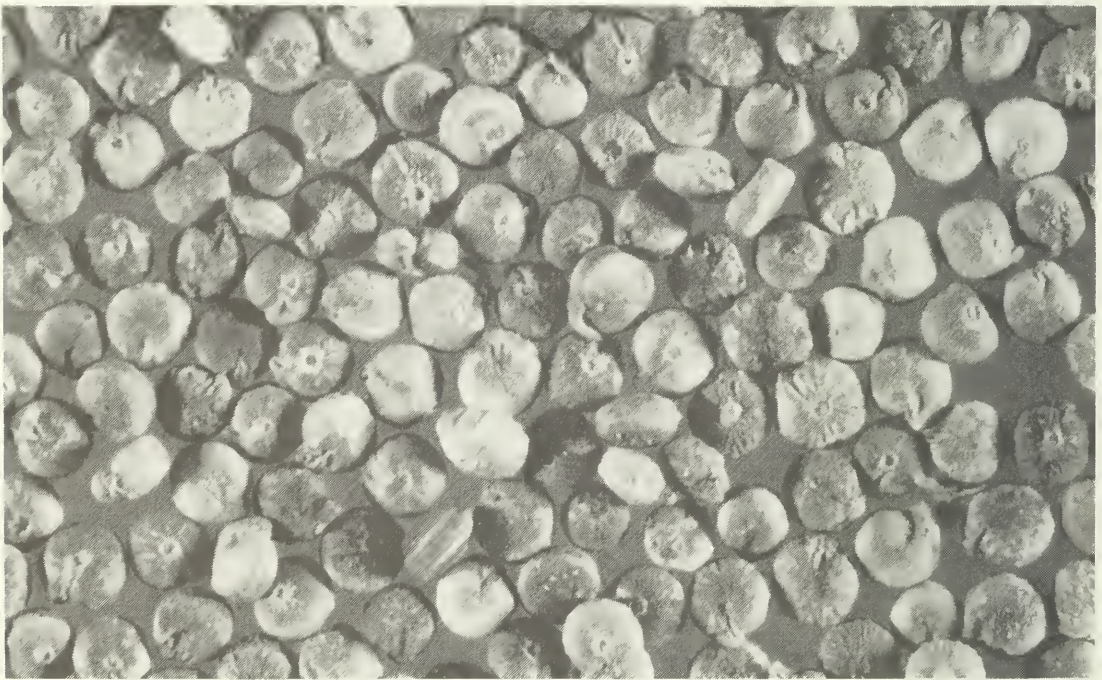
Weed control Control weeds mechanically using cultural management methods only, because herbicides are not registered for this crop.

Insects Flea beetles and an assortment of caterpillars and worms can attack this crop.

Harvesting Harvest with a combine when plants are mature. If plants are still green by mid September, swath them, allow them to dry, and then combine them. Seed can be stored at 12% moisture.

Potential

This crop has a limited potential market in North America in health foods and for people with allergies to traditional grain cereals. Saponins in the outer seed layer must be removed, by either washing or polishing, before quinoa can be used as a food. Further agronomic research and market development are required before expansion can be recommended.



Quinoa plants (*top*); seed (*bottom*).

Tepary bean

Botanical name: *Phaseolus acutifolius* A. Gray var. *latifolius* G. Freem.

Common names: tepary bean, Texan beans, rice haricot bean

Introduction

The tepary bean is native to northwest Mexico, Arizona, and New Mexico. The annual semi-upright bean plant is extremely drought-tolerant. The plant is 35–50 cm high, with vines that receive ample moisture and that measure up to 115 cm long. Yields range from 1150 to 2300 kg/ha, with an average of 1690 kg/ha. Maturity ranges from 86 to 115 days. Under good moisture conditions this plant is more indeterminate than when it is under high moisture stress. Little moisture is required for germination and plant establishment. Lower yields are obtained in cooler conditions with higher rainfall. Yields are best when it is hot and dry.

Cultural information

Planting Plant in the last week of May because warm soils are required for germination. Plant seeds into light, well-drained soil, 2.5–7.5 cm deep (depending on the availability of moisture and the soil type), in a fine, firm seedbed. For effective weed control with row crop equipment, seed at a rate of 25–35 kg/ha in rows 60–90 cm apart.

Fertilizer Requirements are similar to those for field beans.

Weed control The only form of weed control is mechanical and cultural. Herbicides are not registered for this purpose.

Diseases and insects No major disease or insect problems have been noted.

Harvesting Cut the plants when approximately 80% of the seed pods have changed color and are starting to dry down. The seed shatters very easily if left until the plants dry down. The plants can be harvested at a moisture content of 16% or less.

Potential

No known markets currently exist for this crop. However, the economic yield potential is good if markets can be developed. If the climate becomes hotter and drier, the crop will be well adapted to the prairies.



Tepary bean plants (*top*); seed (*bottom*).

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